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U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

ATTORNEY'S DOCKET NUMBER

TRANSMITTAL LETTER TO THE UNITED STATES
DESIGNATED/ELECTED OFFICE (DO/EO/US)
CONCERNING A FILING UNDER 35 U.S.C. 371

4541-004

U.S. APPLICATION NO. (if known, see 37 CFR 1.5)

10/019772

INTERNATIONAL APPLICATION NO.

PCT/KR00/00714

INTERNATIONAL FILING DATE

4 July 2000 (04.07.2000)

PRIORITY DATE CLAIMED

6 July 1999 (06.07.1999)

TITLE OF INVENTION

**DISINTEGRATIVE CORE FOR HIGH PRESSURE CASTING, METHOD FOR
MANUFACTURING THE SAME, AND METHOD FOR EXTRACTING THE SAME**

APPLICANT(S) FOR DO/EO/US

Koji HIROKAWA

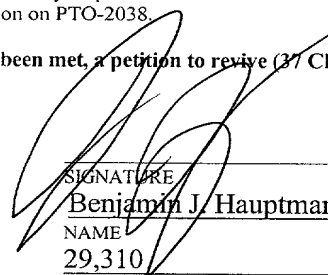
Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☐ This express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1).
4. ☐ A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.
5. ☒ A copy of the International Application as filed (35 U.S.C. 371(c)(2))
 - a. ☒ is transmitted herewith (required only if not transmitted by the International Bureau).
 - b. ☐ has been transmitted by the International Bureau.
 - c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US)
6. ☐ A English translation of the International Application into English (35 U.S.C. 371(c)(2)).
 - a. ☐ is attached hereto
 - b. ☐ has been previously submitted under 35 U.S.C. 154 371 (c)(2)
7. ☐ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))
 - a. ☐ are transmitted herewith (required only if not transmitted by the International Bureau).
 - b. ☐ have been transmitted by the International Bureau.
 - c. ☐ have not been made; however, the time limit for making such amendment has NOT expired.
 - d. ☐ have not been made and will not be made.
8. ☐ A English translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. ☒ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).
10. ☐ A English translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11. to 20. below concern other document(s) or information included:

11. ☒ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. ☒ A FIRST preliminary amendment.
14. ☐ A SECOND or SUBSEQUENT preliminary amendment.
15. ☐ A substitute specification.
16. ☐ A change of power of attorney and/or address letter.
17. ☐ A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 and 35 U.S.C. 1.821-1.825
18. ☐ A second copy of the published international application under 35 U.S.C. 154(d)(4)
19. ☐ A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4)
20. ☒ Other items or information.
 - a. PCT/IB/301 - Notification Of Receipt Of Record Copy

10019772-050900

U.S. APPLIC. NO. (if known, see 37 CFR 1.5) 10/019772		INTERNATIONAL APPLICATION NO. PCT/KR00/00714		ATTORNEY'S DOCKET NUMBER 4541-004	
21. <input checked="" type="checkbox"/> The following fees are submitted: Basic National Fee (37 CFR 1.492(a)(1)-(5)): Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO \$ 1040.00 International Search fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO and JPO \$ 890.00 International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO \$ 740.00 International preliminary examination fee paid to USPTO (37 CFR 1.482) but all claims did not satisfy provisions of PCT Article 33(1)-(4) \$ 710.00 International preliminary examination fee paid to USPTO (37 CFR 1.482) And all claims satisfied provisions of PCT Article 33(2)-(4) \$ 100.00 ENTER APPROPRIATE BASIC FEE AMOUNT =				CALCULATIONS	PTO USE ONLY
				\$ 1,040.00	
Surcharge of \$130.00 for furnishing the oath or declaration later than <input type="checkbox"/> 20 <input checked="" type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492(e)).				\$ 0.00	
CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE		
Total Claims	10 - 20 =	0	X \$18.00	\$ 0.00	
Independent Claims	2 - 3 =	0	X \$84.00	\$ 0.00	
Multiple dependent claim(s) (if applicable)			+ \$280.00	\$ 0.00	
TOTAL OF ABOVE CALCULATIONS =				\$ 1,040.00	
<input type="checkbox"/> Applicant claims small entity status. See 37 CFR 1.27. The fees indicated above are reduced by 1/2.				\$ 0.00	
SUBTOTAL =				\$ 1,040.00	
Processing fee of \$130.00 for furnishing the English translation later than the <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492(f)).				\$ 0.00	
TOTAL NATIONAL FEE =				\$ 1,040.00	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). \$40.00 per property				\$ 0.00	
TOTAL FEES ENCLOSED =				\$ 1,040.00	
				Amount to be: refunded	\$
				charged	\$
a. <input type="checkbox"/> A check in the amount of \$ <u>XXX.XX</u> to cover the above fees is enclosed. b. <input type="checkbox"/> Please charge my Deposit Account No. <u>XXX</u> in the amount of \$ <u>XXX</u> to cover the above fees. A duplicate copy of this sheet is enclosed. c. <input checked="" type="checkbox"/> The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. <u>07-1337</u> . A duplicate copy of this sheet is enclosed. c. <input checked="" type="checkbox"/> Fees are to be charged to a credit card WARNING: information on this form may be public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.					
NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status. SEND ALL CORRESPONDENCE TO:					
LOWE HAUPTMAN GILMAN & BERNER, LLP 1700 Diagonal Road, Suite 310 Alexandria, VA 22314 (703) 684-1111				SIGNATURE  NAME Benjamin J. Hauptman 29,310 REGISTRATION NUMBER	

Docket No.: 4541-004

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of

Koji HIROKAWA

Serial No. Not yet assigned

Filed: January 3, 2002

For: DISINTEGRATIVE CORE FOR HIGH PRESSURE CASTING, METHOD FOR
MANUFACTURING THE SAME, AND METHOD FOR EXTRACTING THE SAME

PRELIMINARY AMENDMENT

Assistant Commissioner For Patents
Washington, D.C. 20231

Dear Sir:

Preliminary to examination of the above-referenced application, please amend the
application:

IN THE CLAIMS:

Please amend claims 4 to 8 as follows:

4. (Amended) The method as set forth in claim 1, wherein the water-soluble
salt is melted at a temperature higher by 30 ~ 80 °C than that of its melting temperature and
solidified in a mold.

5. (Amended) The method as set forth in claim 1, wherein the mold is made of
graphite and heated to half of the melting temperature of the salt.

6. (Amended) The method as set forth in claim 1, wherein the water-soluble
salt is processed into a powder with a particle size of 40 ~ 100 μm, introduced into the mold
and molded under a pressure of 80 ~ 100 Mpa.

7. (Amended) The method as set forth in claim 1, wherein the molten water-soluble salt is added with 5 ~ 30 wt% of chemically non-reactive, fine hard particles, said fine hard particles being selected from the group consisting of powders, fibers and whiskers of metals or ceramics, and mixtures thereof.

8. (Amended) A disintegrative core for high pressure casting, manufactured according to the method of claim 1.

REMARKS

The above-referenced application is amended to delete the multiple dependencies of claims 4 to 8.

Attached hereto is a marked-up version of the changes made to the claims by the current amendment. The attached pages are captioned "Marked-Up Version Showing Changes".

Respectfully submitted,

LOWE HAUPTMAN GILMAN & BERNER, LLP

Benjamin J. Hauptman
Registration Number 29,310

Date: January 4, 2002
1700 Diagonal Road, Suite 310
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MARKED-UP VERSION SHOWING CHANGES

CLAIMS

1. A method for manufacturing a disintegrative core for high pressure casting, wherein a water-soluble salt, alone or in combination with a fine hard powder, is melted and solidified in a core mold; or processed into a fine powder and molded in a core mold under a pressure, said water soluble salt ranging from 280 to 520 °C in melting point and from 9.8×10^{-2} to 1.2×10 W/m·°C in heat transfer coefficient (κ) with a high latent heat, whereby the disintegrative core can be applied where a light metal such as aluminum alloy or magnesium alloy is subjected to high pressure casting, such as die casting or squeeze casting and is manufactured from the water-soluble salt.

2. The method as set forth in claim 1, wherein the water-soluble salt is selected from the group consisting of KNO_3 , KNO_2 , NaNO_3 , NaNO_2 , and mixtures thereof.

3. The method as set forth in claim 1, wherein the water-soluble salt is selected from the group consisting of salt mixtures, by weight percentage, of 82:17 $\text{NaCl}:\text{CuCl}_2$, 92:8 $\text{KNO}_3:\text{KCl}$, 54:46 $\text{KCl}:\text{LiCl}$, 93:7 $\text{PbCl}_2:\text{NaCl}$, 54:44 $\text{MgCl}_2:\text{NaCl}$, 53:47 $\text{CaCl}_2:\text{BaCl}_2$, and 54:46 $\text{NaCl}:\text{CaCl}_2$.

4. The method as set forth in ^{claim 1} ~~any one of claims 1 to 3~~ wherein the water-soluble salt is melted at a temperature higher by 30~80 °C than that of its melting temperature and solidified in a mold.

5. The method as set forth in ^{claim 1} ~~any one of claims 1 to 3~~, wherein the mold is made of graphite and heated to half of the melting temperature of the salt.

MARKED-UP VERSION SHOWING CHANGES

6. The method as set forth in ^{claim 1} ~~any one of claims 1 to 3~~, wherein the water-soluble salt is processed into a powder with a particle size of 40~100 μm , introduced into the mold and molded under a pressure of 80~100 Mpa.

7. The method as set forth in ^{claim 1} ~~any one of claims 1 to 3~~, wherein the molten water-soluble salt is added with 5~30 wt% of chemically non-reactive, fine hard particles, said fine hard particles being selected from the group consisting of powders, fibers and whiskers of metal or ceramics, and mixtures thereof.

8. A disintegrative core for high pressure casting, manufactured according to the method of ^{claim 1} ~~any one of claims 1 to 7~~.

9. A method for extracting a disintegrative core for high pressure casting wherein the core is heated to a melting temperature at which the high pressure cast article is not thermally deformed, the core melt is extracted, and the cast article is washed with water.

10. The method as set forth in claim 9, wherein the high pressure cast article is heated at 320~550 $^{\circ}\text{C}$ for 3~5 minutes, whereby the heat is transferred to the inside of the core so that the core is melted and extracted.

WO 01/02112

PCT/KR00/00714

DISINTEGRATIVE CORE FOR HIGH PRESSURE CASTING, METHOD FOR
MANUFACTURING THE SAME, AND METHOD FOR EXTRACTING THE
SAME

TECHNICAL FIELD

5 The present invention relates to a method for manufacturing a disintegrative
core for high pressure casting, such as die casting or squeeze casting. More
particularly, the present invention relates to the manufacture of complex
disintegrative cores from water-soluble salts. Also, the present invention relates to
such water-soluble salt cores. In addition, the present invention is concerned with
10 a method for extracting such water-soluble salt cores.

PRIOR ART

Generally, a core preparation technique is necessary to prepare cast articles
which have complex internal structures or are undercut.

15 In the case of gravity casting, a disintegrative core made of hard sand or
ceramic powder or a water-soluble salt core is positioned inside a mold, and then a
molten metal is introduced and solidified in the mold. After that, the disintegrative
core is removed by mechanical and chemical methods or the salt core is melted-out
with water or steam.

20 In the case of a piston for an internal combustion engine, the salt core
preparation technique is useful in forming a circular oil cooling gallery inside of the
piston.

U.S. Pat. No. 3,645,491, the content thereof being incorporated herein by
reference, discloses a core preparation technique in which a powdered water-soluble
25 salt is combined with about 10% of synthetic resin as a binding agent. U.S. Pat. No.
4,629,708, the content thereof being incorporated herein by reference, discloses a
core preparation technique in which a water-soluble salt, such as sodium chloride

and potassium chloride, is mixed with ceramics, such as alumina, and silicone resin as a binding agent and sintered.

Under actual circumstances, however, a piston is subjected to high pressure casting, such as die casting and squeeze casting, in order to prepare a high performance aluminum alloy or composite material piston.

In such a high pressure casting, a conventional disintegrative core made of sand or a conventional salt core cannot be applied to a high pressure casting method because the molten metal penetrates into the inside of the core by cast pressure or the core is collapsed by high pressure.

Recently, there are developed several kinds of core preparation techniques capable of being used where high pressure casting is required. For instance, U.S. Pat. No. 3,963,818, the content thereof being incorporated herein by reference, discloses a core preparation technique in which a powdered water-soluble salt, such as sodium chloride and potassium chloride, is added with about 1 % of water, molded under a high pressure of 1.8~4.0 ton/cm², then sintered at 100~300 °C for 20 minutes.

U.S. Pat. No. 4,438,804, the content thereof being incorporated herein by reference, discloses a core molding method in which a water-soluble salt powder is mixed with hard powder such as Zircon sand, and molded, along with potassium carbonate, barium carbonate or alkali silicate as a binding agent, under a high pressure.

U.S. Pat. No. 3,407,864, the content thereof being incorporated herein by reference, discloses a core molding method in which a water-soluble salt powder, such as sodium chloride and potassium chloride, is mixed with 3 wt% of borax, 1 wt% of magnesium oxide and 1 wt% of talc, and molded under a high pressure.

G.B. Pat. No. 2,156,720, the content thereof being incorporated herein by reference, discloses a core preparation technique in which a powdered water-soluble salt is hydrostatic-pressurized.

In these preparation methods using high pressures or hydrostatic pressures, voids between particles are minimized and their bonding force is strengthened so as

for the core to keep its shape unchanged at a cast pressure of 5,000~20,000 psi and so as to prevent the molten metal from penetrating into the inside of the core.

However, these conventional methods suffer from disadvantages in that their application is restricted by the size and shape of cores and the production cost is increased because particle sizes of salt powders are required to be finely controlled.

In addition, it takes a significant amount of time to completely remove cores from the high pressure cast articles because the cores are dissolved with water.

Meanwhile, U.S. Pat. Nos. 4,446,906, 4,875,517, and 5,303,761, the contents thereof being incorporated herein by reference, disclose core preparation methods in which a water-soluble salt such as sodium chloride and potassium chloride are heated, melted, and subjected to die casting, optionally in combination with hard particles, such as silica and alumina.

Somewhat superior as it is to molding methods in core shape and productivity, these conventional methods are limited in their application by the size of the core. In addition, the conventional methods require a significant amount of time to completely remove cores from high pressure cast articles when water is used to dissolve the cores.

U.S. Pat. No. 4,840,219, the content thereof being incorporated herein by reference, discloses a method in which a molten salt of a mixture comprising 40 % by weight of NaCl and 40 % by weight of Na_2CO_3 is added with 10~50 % of hard powder to give a slurry which is introduced into a mold. U.S. Pat. No. 3,459,253, the content thereof being incorporated herein by reference, discloses a method in which wire or glass fiber is added to the molten mixture salt comprising sulfate salt and carbonate salt to give a slurry which is introduced into a mold.

These methods have more variety in shape and size of the core than does the pressurization method or the die cast method. Meanwhile, because the used salts are as high as above 660 °C in melting temperature, cracks are easily caused owing to the shrinkage upon solidification so that the cores become brittle and are difficult to handle. Additionally, a substantial period of time is required to remove the cores

of high pressure cast articles because the cores must be dissolved by use of water, and the core salts thus obtained cannot be re-used.

DISCLOSURE OF THE PRESENT INVENTION

5 In view of the aforementioned problems and considerations, it is an object of the present invention to provide a method for manufacturing a disintegrative core for high pressure casting, capable of simply manufacturing a core of a complex shape and obtaining a core for high pressure casting by use of a re-usable aluminum alloy or a magnesium alloy.

10 It is another object of the present invention to provide a disintegrative core for high pressure casting.

It is a further object of the present invention to provide a method for extracting the core.

15 In one embodiment, one of the objects of the present invention is realized by the method for manufacturing the disintegrative core for high pressure casting, wherein a water-soluble salt, alone or in combination with a fine hard powder, is melted and solidified in a core mold; or processed into a fine powder and molded in a core mold under pressure, said water soluble salt ranging from 280 to 520 °C in melting point and from 9.8×10^{-2} to 1.2×10 W/m²·°C in heat transfer coefficient (κ)
20 with a high latent heat, whereby the disintegrative core is manufactured from the water-soluble salt.

In another embodiment, another object of the present invention is embodied by the disintegrative core for high pressure casting manufactured through the said method.

25 In a further embodiment, the other object is realized by the method for extracting the disintegrative core for high pressure casting from a high pressure cast article, wherein the core is heated to a melting temperature at which the high pressure cast article is not thermally deformed, the core melt is extracted, and the cast article is washed with water.

BEST MODES CARRYING OUT THE PRESENT INVENTION

Hereinafter, the present invention describes a disintegrative core for high-pressure casting, and methods for manufacturing and extracting the same.

A disintegrative core for high pressure casting is manufactured from a water-soluble salt, wherein the water-soluble salt, alone or in combination with a fine hard powder, is melted and solidified in a core mold; or processed into a fine powder and molded in a core mold under a pressure, said water soluble salt ranging from 280 to 520 °C in melting point and from 9.8×10^{-2} to 1.2×10 W/m·°C in heat transfer coefficient (κ) with a high latent heat, whereby the disintegrative core can be applied where a light metal such as aluminum alloy or magnesium alloy is subjected to high pressure casting, such as die casting or squeeze casting.

As having a melting point of 280 to 520 °C and a heat transfer coefficient (κ) of 9.8×10^{-2} to 1.2×10 W/m·°C and being high in latent heat, the water-soluble salt is selected from the group consisting of potassium nitrate (KNO_3), potassium nitrite (KNO_2), sodium nitrate (NaNO_3), sodium nitrite (NaNO_2), copper chloride (CuCl_2), sodium chloride (NaCl), potassium chloride (KCl), lithium chloride (LiCl), lead chloride (PbCl_2), magnesium chloride (MgCl_2), barium chloride (BaCl_2), calcium chloride (CaCl_2) and mixtures thereof.

In regard to melting point, 333 °C is known for potassium nitrate (KNO_3), 290 °C for potassium nitrite (KNO_2), 308 °C for sodium nitrate (NaNO_3) and 270 °C for sodium nitrite (NaNO_2).

315 °C is measured to be the melting temperature for the mixture salt comprising, by weight ratio, 82:17 $\text{NaCl}:\text{CuCl}_2$, 320 °C for the mixture salt comprising, by weight ratio, 92:8 $\text{KNO}_3:\text{KCl}$, 320 °C for the mixture salt comprising, by weight ratio, 54:46 $\text{KCl}:\text{LiCl}$, 410 °C for the mixture salt comprising, by weight ratio, 93:7 $\text{PbCl}_2:\text{NaCl}$, 430 °C for the mixture salt comprising, by weight ratio, 54:44 $\text{MgCl}_2:\text{NaCl}$, 450 °C for the mixture salt comprising, by weight ratio, 53:47 $\text{CaCl}_2:\text{BaCl}_2$ and 510 °C for the mixture salt

comprising, by weight ratio, 54:46 NaCl:CaCl₂, and each salt ranges from 9.8×10^{-2} to 1.2×10 W/m²·°C in heat transfer coefficient (κ).

Such a water-soluble salt is solidified in a mold. At this time, the molten water-soluble salt is introduced into the mold at a temperature higher by about
5 30~80 °C than that of its melting temperature, thereby minimizing the occurrence of cracks attributed to the shrinkage upon solidification.

In this regard, if the temperature of the molten water-soluble salt is above 80 °C, shrinkage-attributable cracks and pores are generated upon solidification. On the other hand, if the temperature is below 30 °C, the water-soluble salt is difficult to
10 inject into a mold.

In addition, the mold temperature is controlled not to exceed half of the melting point of each salt to be introduced. The reason is that, if the mold temperature is lower, the salt is not well introduced into the mold. On the other hand, if the temperature of the mold is higher, the surface structure of the solidified
15 core becomes so coarse that a thermal deformation occurs in deep parts of the core upon high pressure casting.

Accordingly, suitable for mold material is graphite, which is excellent in thermal conductivity. When the mold is made of graphite, the molten salt is easily introduced into the mold and the solidification rate becomes so fast that the surface
20 texture of the solidified core is made fine.

In the molten salt, fine thermostable hard particles such as powders, fibers and whiskers of chemically non-reactive metals or ceramics, may be added. For use, they are homogeneously dispersed.

By way of examples, and not limitation, suitable for metal particles is
25 silicon with a high solidity and a similar specific gravity to that of the salt. Also, alumina (Al₂O₃), silicon carbide (SiC) and so on can be used as the ceramic particles. Such fibers or whiskers can be used.

The hard particles are preferably added at an amount of 5~30 wt%. If the added amount of the hard particles is above 30 wt%, the shrinkage upon
30 solidification can be inhibited and a strength of the core attributed to dispersion

effect becomes high. But it suffers from a problem of the hard particles partly adhering onto a surface of a high pressure cast article. On the other hand, if the added amount is below 5 wt%, the addition effect of the hard particles cannot be obtained.

5 The water-soluble salt is processed into a powder, introduced into a core mold and molded to a core. In this regard, it is extremely preferred that the water-soluble salt powder has a size of 40~100 μm for the molding under pressure. Also, a lubricant not chemically reacting with the salt is preferably used so as to facilitate the separation of the cast article from the mold.

10 At this time, it is preferred that the molding pressure resulting from the pressurization ranges from 60 to 100 Mpa. In addition, the molded core is preferably kept at its melting point for 0.5~1 minute, so as to make the surface texture of the core fine.

15 The core obtained according to the method of the present invention can be used where a metal alloy such as an aluminum alloy or a magnesium alloy is subjected to high pressure casting.

20 Upon the high pressure casting of a metal with a low thermal capacity, such as an aluminum alloy and a magnesium alloy, the mold is instantly filled with the melt within 0.5~3 seconds. Because the metal alloy such as an aluminum alloy or a magnesium alloy, although having a melting point (280~520 $^{\circ}\text{C}$) lower than a usual casting temperature (640~720 $^{\circ}\text{C}$) of common molten metals, has a heat transfer coefficient (κ) ($9.8 \times 10^{-2} \sim 1.2 \times 10$ W/m. $^{\circ}\text{C}$) which is only 1/1500~1/3000 of that (331~403 W/m. $^{\circ}\text{C}$) of steel, which is a typical material for high pressure casting molds. The molten alloy is drastically cooled as soon as it is introduced into the
25 mold.

In detail, because the core is lower in thermal conductivity than is steel, a material for the mold, most of the heat that the melt retains is transferred toward the mold while the heat is hardly transferred toward the core. Meanwhile, the high latent heat of the core permits a thermal deformation to occur only in the surface

down to a depth of 2-3 μm , but not in the total shape. In other words, the core is not deformed, nor changed in its total shape by virtue of its high latent heat.

In such general casting as high pressure casting which is instantly completed, the water-soluble salts of the present invention are suitable as cores for casting metals with low thermal capacity such as aluminum and magnesium.

Meanwhile, a method for removing the core from a high pressure cast article, that is to say, a method for extracting the core from the cast article, is conducted by heating the core to a melting temperature at which the high pressure cast article is not thermally deformed, extracting the core melt, and washing the cast article with water.

When the high pressure cast article is heated at 320~550 $^{\circ}\text{C}$ for 3~5 minutes, the heat is transferred to the inside of the core so that the core is melted and extracted. The material thus obtained can be re-used in molding of the core to bring about an economical favor.

A better understanding of the present invention may be obtained in light of the following examples which are set forth to illustrate, but are not to be construed to limit the present invention.

EXAMPLE 1

KNO_3 (m.p. 333 $^{\circ}\text{C}$), KNO_2 (m.p. 290 $^{\circ}\text{C}$), NaNO_3 (m.p. 308 $^{\circ}\text{C}$), NaNO_2 (m.p. 270 $^{\circ}\text{C}$), a mixture of 82:17 $\text{NaCl}:\text{CuCl}_2$ (m.p. 315 $^{\circ}\text{C}$), a mixture of 92:8 $\text{KNO}_3:\text{KCl}$ (m.p. 320 $^{\circ}\text{C}$), a mixture of 54:46 $\text{KCl}:\text{LiCl}$ (m.p. 320 $^{\circ}\text{C}$), a mixture of 93:7 $\text{PbCl}_2:\text{NaCl}$ (m.p. 410 $^{\circ}\text{C}$), a mixture of 54:44 $\text{MgCl}_2:\text{NaCl}$ (m.p. 430 $^{\circ}\text{C}$), a mixture of 53:47 $\text{CaCl}_2:\text{BaCl}_2$ (m.p. 450 $^{\circ}\text{C}$), and a mixture of 54:46 $\text{NaCl}:\text{CaCl}_2$ (m.p. 510 $^{\circ}\text{C}$) were individually heated at temperatures which were higher by about 30~80 $^{\circ}\text{C}$ than their melting points, respectively. Each of the molten salts was slowly introduced into a mold and separately into a graphite mold, both of which were preheated to half of the melting point of the salt, to manufacture a cylindrical core with a diameter of 20 mm and a length of 100 mm.

The resulting core was subjected to die casting and squeeze casting in the mold whose wall was set to be spaced from the core at a distance of 3 mm, 5 mm, 7 mm, 9 mm, 12 mm, and 15mm, and measured for its performance. Results are given in Tables 1 and 2, below.

- 5 For assaying the performance of the core, ADC12 Al alloy heated to 670 °C was subjected to high pressure casting under conditions of 1.8 m/sec in feeding rate of a melt for die casting, 0.32 m/sec in feeding rate of a melt for squeeze casting, and 980 kg/cm² in pressure for die casting and squeeze casting. After the high pressure casting, the extraction of the core was achieved by heating the high pressure cast article at 320~550 °C for 3~5 minutes, melting the core, and washing the cast article with water.

TABLE 1
Performance of Cores Prepared in Steel Mold

Cores	Die Casting (Gap between core and mold, mm)						Squeeze Casting (Gap between core and mold, mm)					
	3	5	7	9	12	15	3	5	7	9	12	15
NaNO ₂	0	0	×	×	×	×	0	×	×	×	×	×
KNO ₂	0	0	×	×	×	×	0	×	×	×	×	×
NaNO ₃	0	0	0	×	×	×	0	×	×	×	×	×
NaCl:CuCl(82:17)	0	0	0	×	×	×	0	×	×	×	×	×
KNO ₃ :KCl(92:8)	0	0	0	0	×	×	0	0	×	×	×	×
KCl:LiCl(54:46)	0	0	0	0	×	×	0	0	×	×	×	×
KNO ₃	0	0	0	0	0	×	0	0	0	×	×	×
PbCl ₂ :NaCl(93:7)	0	0	0	0	0	0	0	0	0	0	×	×
MgCl ₂ :NaCl(54:44)	0	0	0	0	0	0	0	0	0	0	0	×
CaCl ₂ :BaCl ₂ (53:47)	0	0	0	0	0	0	0	0	0	0	0	×
NaCl:CaCl ₂ (54:46)	0	0	0	0	0	0	0	0	0	0	0	×

Note) O : suitable (good surface condition)

×: unsuitable (poor surface condition)

TABLE 2
Performance of Cores Prepared in Graphite Mold

Cores	Die Casting (Gap between core and mold, mm)						Squeeze Casting (Gap between core and mold, mm)					
	3	5	7	9	12	15	3	5	7	9	12	15
NaNO ₂	0	0	0	×	×	×	0	×	×	×	×	×
KNO ₂	0	0	0	0	×	×	0	×	×	×	×	×
NaNO ₃	0	0	0	0	×	×	0	0	×	×	×	×
NaCl:CuCl(82:17)	0	0	0	0	0	×	0	0	0	×	×	×
KNO ₃ :KCl(92:8)	0	0	0	0	×	×	0	0	0	×	×	×
KCl:LiCl(54:46)	0	0	0	0	0	×	0	0	0	×	×	×
KNO ₃	0	0	0	0	0	0	0	0	0	0	×	×
PbCl ₂ :NaCl(93:7)	0	0	0	0	0	0	0	0	0	0	×	×
MgCl ₂ :NaCl(54:44)	0	0	0	0	0	0	0	0	0	0	0	×
CaCl ₂ :BaCl ₂ (53:47)	0	0	0	0	0	0	0	0	0	0	0	×
NaCl:CaCl ₂ (54:46)	0	0	0	0	0	0	0	0	0	0	0	×

Note) O : suitable (good surface condition)

×: unsuitable (poor surface condition)

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EXAMPLE 2

KNO₃ (m.p. 333 °C), KNO₂ (m.p. 290 °C), NaNO₃ (m.p. 308 °C), NaNO₂ (m.p. 270 °C), a mixture of 82:17 NaCl:CuCl₂ (m.p. 315 °C), a mixture of 92:8 KNO₃:KCl (m.p. 320 °C), a mixture of 54:46 KCl:LiCl (m.p. 320 °C), a mixture of 93:7 PbCl₂:NaCl (m.p. 410 °C), a mixture of 54:44 MgCl₂:NaCl (m.p. 430 °C), a mixture of 53:47 CaCl₂:BaCl₂ (m.p. 450 °C), and a mixture of 54:46 NaCl:CaCl₂ (m.p. 510 °C) were individually heated at temperatures which were higher by about 30~80 °C than their melting points, respectively. 20~30 wt% of Alumina (Al₂O₃: Isolite.Co.Ltd., Japan) which was 40~100 μm in diameter was added to the heated solution and homogeneously dispersed. Then, this dispersion was slowly introduced into a graphite mold which was preheated to half of each melting point, to manufacture a cylindrical core with a diameter of 20 mm and a length of 100 mm.

Likewise, 5~15 wt% of silicon carbide whisker (SiC: TongHae Carbon Co. Ltd., Japan) which was 0.5~1 μm in diameter and 100~400 μm in length was homogeneously dispersed to manufacture a core.

The resulting core was subjected to die casting and squeeze casting in the mold whose wall was set to be spaced from the core at a distance of 3 mm, 5 mm, 7 mm, 9 mm, 12 mm, and 15mm, and measured for its performance. Results are given in Table 3, below.

For assaying the performance of the core, ADC12 Al alloy heated to 670 °C was subjected to high pressure casting under conditions of 1.8 m/sec in feeding rate of a melt for die casting, 0.32 m/sec in feeding rate of a melt for squeeze casting, and 980 kg/cm² in pressure for die casting and squeeze casting. After the high pressure casting, the extraction of the core was achieved by heating the high pressure cast article at 320~550 °C for 3~5 minutes, melting the core, and washing the cast article with water.

TABLE 3

Performance of Cores Prepared from Mixtures of Hard Particles in Graphite Mold

Cores	Die Casting (Gap between core and mold, mm)						Squeeze Casting (Gap between core and mold, mm)					
	3	5	7	9	12	15	3	5	7	9	12	15
$\text{NaNO}_2 + \text{Al}_2\text{O}_3$	0	0	0	0	×	×	0	0	×	×	×	×
$\text{KNO}_2 + \text{SiC}$	0	0	0	0	×	×	0	0	×	×	×	×
$\text{NaNO}_3 + \text{Al}_2\text{O}_3$	0	0	0	0	×	×	0	0	0	×	×	×
$\text{NaCl}:\text{CuCl}(82:17) + \text{Al}_2\text{O}_3$	0	0	0	0	0	×	0	0	0	×	×	×
$\text{KNO}_3:\text{KCl}(92:8) + \text{Al}_2\text{O}_3$	0	0	0	0	0	×	0	0	0	0	×	×
$\text{KCl}:\text{LiCl}(54:46) + \text{SiC}$	0	0	0	0	0	0	0	0	0	0	0	×
$\text{KNO}_3 + \text{SiC}$	0	0	0	0	0	0	0	0	0	0	0	×
$\text{PbCl}_2:\text{NaCl}(93:7) + \text{Al}_2\text{O}_3$	0	0	0	0	0	0	0	0	0	0	0	0
$\text{MgCl}_2:\text{NaCl}(54:44) + \text{SiC}$	0	0	0	0	0	0	0	0	0	0	0	0
$\text{CaCl}_2:\text{BaCl}_2(53:47) + \text{SiC}$	0	0	0	0	0	0	0	0	0	0	0	0
$\text{NaCl}:\text{CaCl}_2(54:46) + \text{Al}_2\text{O}_3$	0	0	0	0	0	0	0	0	0	0	0	0

Note) 0 : suitable(good surface condition)

× : unsuitable(poor surface condition)

EXAMPLE 3

5 KNO_3 (m.p. 333 °C), KNO_2 (m.p. 290 °C), NaNO_3 (m.p. 308 °C), NaNO_2 (m.p. 270 °C), a mixture of 82:17 $\text{NaCl}:\text{CuCl}_2$ (m.p. 315 °C), a mixture of 92:8 $\text{KNO}_3:\text{KCl}$ (m.p. 320 °C), a mixture of 54:46 $\text{KCl}:\text{LiCl}$ (m.p. 320 °C), a mixture of 93:7 $\text{PbCl}_2:\text{NaCl}$ (m.p. 410 °C), a mixture of 54:44 $\text{MgCl}_2:\text{NaCl}$ (m.p. 430 °C), a mixture of 53:47 $\text{CaCl}_2:\text{BaCl}_2$ (m.p. 450 °C), and a mixture of 54:46 $\text{NaCl}:\text{CaCl}_2$ (m.p. 510 °C) were ground to particle sizes of about 40~100 μm , added with 1 wt% of talc as a lubricant and pressurized to a pressure of 80~100 Mpa, to mold a cylindrical core with a diameter of 20 mm and a length of 100 mm. The molded core was kept at the melting point of each salt for 0.5~1 minute to manufacture a core.

15 15 wt% of Alumina (Al_2O_3 : Isolute.Co.Ltd., Japan) which was 40~100 μm in diameter and 8 wt% of silicon carbide whisker (SiC : TongHae Carbon Co. Ltd., Japan) which was 0.5~1 μm in diameter and 100~400 μm in length were added to the salt powder and homogeneously mixed to manufacture a core.

The resulting core was subjected to die casting and squeeze casting in the mold whose wall was set to be spaced from the core at a distance of 3 mm, 5 mm, 7 mm, 9 mm, 12 mm, and 15mm, and measured for its performance. Results are given in Table 4, below.

25 For assaying the performance of the core, ADC12 Al alloy heated to 670 °C was subjected to high pressure casting under conditions of 1.8 m/sec in feeding rate of a melt for die casting, 0.32 m/sec in feeding rate of a melt for squeeze casting, and 980 kg/cm^2 in pressure for die casting and squeeze casting. After the high pressure casting, the extraction of the core was achieved by heating the high pressure cast article at 320~550 °C for 3~5 minutes, melting the core, and washing the cast article with water.

30

TABLE 4

Performance of Cores Molded from Mixtures of Hard Particles Under Pressure

Cores	Die Casting (Gap between core and mold, mm)						Squeeze Casting (Gap between core and mold, mm)					
	3	5	7	9	12	15	3	5	7	9	12	15
$\text{NaNO}_2 + \text{Al}_2\text{O}_3$	0	0	0	0	×	×	0	0	0	×	×	×
$\text{KNO}_2 + \text{SiC}$	0	0	0	0	×	×	0	0	0	×	×	×
$\text{NaNO}_3 + \text{Al}_2\text{O}_3$	0	0	0	0	0	×	0	0	0	0	×	×
$\text{NaCl}:\text{CuCl}(82:17) + \text{Al}_2\text{O}_3$	0	0	0	0	0	×	0	0	0	0	×	×
$\text{KNO}_3:\text{KCl}(92:8) + \text{Al}_2\text{O}_3$	0	0	0	0	×	×	0	0	0	0	×	×
$\text{KCl}:\text{LiCl}(54:46) + \text{SiC}$	0	0	0	0	0	×	0	0	0	0	0	×
$\text{KNO}_3 + \text{SiC}$	0	0	0	0	0	0	0	0	0	0	0	×
$\text{PbCl}_2:\text{NaCl}(93:7) + \text{Al}_2\text{O}_3$	0	0	0	0	0	0	0	0	0	0	0	0
$\text{MgCl}_2:\text{NaCl}(54:46) + \text{SiC}$	0	0	0	0	0	×	0	0	0	0	0	×
$\text{CaCl}_2:\text{BaCl}_2(53:47) + \text{SiC}$	0	0	0	0	0	0	0	0	0	0	0	0
$\text{NaCl}:\text{CaCl}_2(54:46) + \text{Al}_2\text{O}_3$	0	0	0	0	0	0	0	0	0	0	0	0

Note) 0 : suitable(good surface condition)

× : unsuitable(poor surface condition)

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INDUSTIRAL APPLICABILITY

As described hereinbefore, cores of complex shapes can be simply manufactured from a water-soluble salt, wherein the water-soluble salt, alone or in combination with a fine hard powder, is melted and solidified in a core mold, the salt ranging from 280 to 520 °C in melting point and from 9.8×10^{-2} to 1.2×10 W/m·°C in heat transfer coefficient (κ) with a high latent heat. In addition, the core can be applied where light metal, such as aluminum alloy or magnesium alloy, is subjected to high pressure casting, such as die casting and squeeze casting. Finally, the core, heated and melted and extracted, can be re-used so as to bring about an economical favor.

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CLAIMS

1. A method for manufacturing a disintegrative core for high pressure casting, wherein a water-soluble salt, alone or in combination with a fine hard powder, is melted and solidified in a core mold; or processed into a fine powder and molded in a core mold under a pressure, said water soluble salt ranging from 280 to 520 °C in melting point and from 9.8×10^{-2} to 1.2×10 W/m·°C in heat transfer coefficient (κ) with a high latent heat, whereby the disintegrative core can be applied where a light metal such as aluminum alloy or magnesium alloy is subjected to high pressure casting, such as die casting or squeeze casting and is manufactured from the water-soluble salt.

2. The method as set forth in claim 1, wherein the water-soluble salt is selected from the group consisting of KNO_3 , KNO_2 , NaNO_3 , NaNO_2 , and mixtures thereof.

3. The method as set forth in claim 1, wherein the water-soluble salt is selected from the group consisting of salt mixtures, by weight percentage, of 82:17 $\text{NaCl}:\text{CuCl}_2$, 92:8 $\text{KNO}_3:\text{KCl}$, 54:46 $\text{KCl}:\text{LiCl}$, 93:7 $\text{PbCl}_2:\text{NaCl}$, 54:44 $\text{MgCl}_2:\text{NaCl}$, 53:47 $\text{CaCl}_2:\text{BaCl}_2$, and 54:46 $\text{NaCl}:\text{CaCl}_2$.

4. The method as set forth in any one of claims 1 to 3, wherein the water-soluble salt is melted at a temperature higher by 30~80 °C than that of its melting temperature and solidified in a mold.

5. The method as set forth in any one of claims 1 to 3, wherein the mold is made of graphite and heated to half of the melting temperature of the salt.

6. The method as set forth in any one of claims 1 to 3, wherein the water-soluble salt is processed into a powder with a particle size of 40~100 μm , introduced into the mold and molded under a pressure of 80~100 Mpa.

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7. The method as set forth in any one of claims 1 to 3, wherein the molten water-soluble salt is added with 5~30 wt% of chemically non-reactive, fine hard particles, said fine hard particles being selected from the group consisting of powders, fibers and whiskers of metal or ceramics, and mixtures thereof.

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8. A disintegrative core for high pressure casting, manufactured according to the method of any one of claims 1 to 7.

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9. A method for extracting a disintegrative core for high pressure casting wherein the core is heated to a melting temperature at which the high pressure cast article is not thermally deformed, the core melt is extracted, and the cast article is washed with water.

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10. The method as set forth in claim 9, wherein the high pressure cast article is heated at 320~550 $^{\circ}\text{C}$ for 3~5 minutes, whereby the heat is transferred to the inside of the core so that the core is melted and extracted.

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(54) Title: **DISINTEGRATIVE CORE FOR HIGH PRESSURE CASTING, METHOD FOR MANUFACTURING THE SAME, AND METHOD FOR EXTRACTING THE SAME**

(57) Abstract: Disclosed is a method for manufacturing a disintegrative core for use in high pressure casting. The disintegrative core can be applied where a light metal such as an aluminum alloy or magnesium alloy is subjected to high pressure casting, such as die casting or squeeze casting and is manufactured from a water-soluble salt which is high in latent heat and ranges, in melting point, from 280 to 520 °C and, in heat transfer coefficient (κ), from 9.8×10^{-2} to 1.2×10 W/m² °C. The water-soluble salt, alone or in combination with a fine hard powder, is melted and solidified in a core mold. Alternatively, the melt is processed into a fine powder which is then molded in a core mold. The method can be applied for the manufacture of complex shapes of cores. Also, disclosed is a method for extracting such a core from a high pressure molded product.

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ATTORNEY DOCKET NO.

DECLARATION FOR PATENT APPLICATION AND APPOINTMENT OF ATTORNEY

As a below-named inventor, I hereby declare that my residence, post office address and citizenship are as stated below next to my name. I believe that I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention (Design, if applicable): **DISINTEGRATIVE CORE FOR HIGH PRESSURE CASTING, METHOD FOR MANUFACTURING THE SAME, AND METHOD FOR EXTRACTING THE SAME.**

the specification of which (check one):

- ☐ is attached hereto.
☐ was filed on _____ as Application Serial No. _____
☐ was filed on 4 July 2000 as International Application (PCT) No. PCT/KR00/00714 and was amended on _____ (if applicable).

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment(s) referred to above. I acknowledge the duty to disclose all information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, § 1.56. I hereby claim foreign priority benefits under Title 35, United States Code § 119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which the priority is claimed.

PRIOR FOREIGN APPLICATION(S)

NUMBER	COUNTRY	DAY/MONTH/YEAR FILED	PRIORITY CLAIMED
1999-27082	KOREA	06/07/1999	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No
			<input type="checkbox"/> Yes <input type="checkbox"/> No

I hereby claim the benefit under Title 35, United States Code, § 120 of any United States application(s) or PCT international application(s) designating The United States of America listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in that/those prior application(s) in the manner provided by the first paragraph of Title 35, United States Code, § 112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, § 1.56 which occurred between the filing date of the prior application(s) and the national or PCT international filing date of this application:

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine, or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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